Module 2 - To Err is Human

ME3023 - Measurements in Mechanical Systems

Mechanical Engineering

Tennessee Technological University

Topic 2 - Errors and Uncertainty

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- Random and Systematic Errors
- Dart Board Example
- Types of Errors
- Sample Uncertainty Data

Random and Systematic Errors

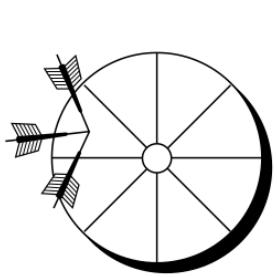
"Errors are effects that cause a measured value to differ from its true value. _____ error causes a _____ variation in measured values found during repeated measurements of a variable.

_____ error causes an offset between the mean value of the data set and its true value. Both _____ and _____ errors affect a system's accuracy."

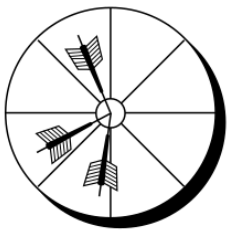
Text: Theory and Design of Mech. Meas.

Dart Board Example

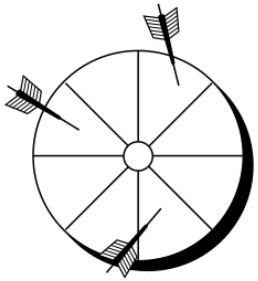
"The concept of accuracy and the effects of systematic and random errors in instruments and measurement systems can be illustrated by the throw of darts."



(a) High repeatability gives low random error but no direct indication of accuracy.



(b) High accuracy means low random and systematic errors.



(c) Systematic and random errors lead to poor accuracy.

"The ability of a measurement system to indicate the same value on repeated but independent application of the same input provides a measure of the instrument _____ ."

Text, Image: Theory and Design of Mech. Meas.

Types of Errors

Common categories of errors in measurements are shown below. This is not an exhaustive list.

- Linearity Error
- Sensitivity
- Zero (offset) Error
- Hysteresis Error
- Overall Instrument Error

$$u_c = \sqrt{u_1^2 + u_2^2 + ... + u_M^2}$$

Sample Uncertainty Data

Table 1.1 Manufacturer's Specifications: Typical Pressure Transducer

Operation	
Input range	0–1000 cm H_2O
Excitation	±15 V DC
Output range	0–5 V
Performance	
Linearity error	±0.5% FSO
Hysteresis error	Less than ±0.15% FSO
Sensitivity error	±0.25% of reading
Thermal sensitivity error	±0.02%/°C of reading
Thermal zero drift	±0.02%/°C FSO
Temperature range	0–50 °C

FSO, full-scale operating range.

Text, Image, Data: Theory and Design of Mech. Meas.